PUF Evaluation Metrics

What follows shows a number of metrics used to evaluate PUF designs:

Intra Hamming distance

On flipping a bit in the challenge to a PUF, ideally, the hamming distance between the responses should differ 50% of total responses bits. If the there are k-chips and the challenges C1 and C2 differ by a bit, and the intra HD is estimated as

$$\text{Intra HD} = \frac{1}{k}\sum_{i=1}^{k}\frac{HD(R_{i,1},R_{i,2})}{n} \times 100\%$$

where Ri,1 is the response from chip 'i' for challenge C1 and Ri,2 is the response from chip 'i' for challenge C2.

Inter Hamming distance

On applying the same challenge to two different PUF designs, ideally, the hamming distance between their responses should differ 50% of total responses bits. If the there are k-chips, then the inter HD for a challenge C is defined as

$$\text{Inter HD} = \frac{2}{k(k-1)}\sum_{i=1}^{k-1}\sum_{j=1+1}^{k}\frac{HD(R_i,R_j)}{n} \times 100\%$$

where 'i' and 'j' are two different chips. Ri is the response from chip 'i' for the challenge C. Rj is the response from chip 'j' for the challenge C.

Uniformity

This metric defines how uniform the proportion of '1's and '0's in the response bits of a PUF. If the PUF has a bias towards '1' or '0' in its responses, then the attacker can guess that response. For an ideal PUF, the proportion of '1's and '0's in its responses should be equal. Uniformity for a PUF 'i' producing a n-bit response for a challenge C is estimated as

$$\text{Uniformity}_i = \frac{1}{n}\sum_{j=1}^{n} R_{i,j} \times 100\%$$

where Ri,j is 1, if the jth bit from the chip 'i' for the challenge C is 1. Otherwise, it is 0. Ideally, this value should be 50%.

Bit-Flip

If bit aliasing happens, then different chips will produce similar responses. Consequently, an attacker can easily guess the response. Bit aliasing for the ith bit of a PUF across K different chips for a challenge C is estimated as

$$\text{Bit aliasing}_i = \frac{1}{k}\sum_{j=1}^{k} R_{i,j} \times 100\%$$

where Ri,j is 1, if the ith bit from the chip 'j' for the challenge C is 1. Otherwise, it is 0. Ideally, this value should be 50%.